

## INFORMATION SHEET

ORDER NO. R5-2007- XXXX  
THE BOEING COMPANY  
SIGMA COMPLEX INSITU GROUNDWATER BIOREMEDIATION PROJECT  
INACTIVE RANCHO CORDOVA TEST SITE  
SACRAMENTO COUNTY

### **Background**

The Boeing Company (Boeing), along with Aerojet-General Corporation (Aerojet), as directed by the Central Valley Regional Water Quality Control Board (Regional Board) and the Department of Toxic Substances Control (DTSC), are initiating cleanup of groundwater beneath the Inactive Rancho Cordova Test Site (IRCTS). The IRC TS consists of approximately 4000 acres in eastern Sacramento County to the east of Sunrise Boulevard, south of White Rock Road, and north of Douglas Road. Past rocket testing operations and disposal practices by The McDonnell-Douglas Corporation and/or Aerojet, have caused the groundwater beneath the IRC TS to have become polluted with volatile organic contaminants (VOCs) and perchlorate. Several plumes of contaminants originate on the IRC TS with the largest plume extending approximately 2.7 miles west of the IRC TS.

Groundwater beneath the IRC TS is contaminated by VOCs and perchlorate. The primary VOCs in the groundwater are trichloroethylene (TCE) and cis-1,2-Dichloroethylene (cis-1,2-DCE) at concentrations up to 710 micrograms per liter ( $\mu\text{g/L}$ ) and 25  $\mu\text{g/L}$ , respectively. Concentrations of perchlorate have been measured up to 32,000  $\mu\text{g/L}$ . Boeing and Aerojet have completed an Engineering Evaluation/Cost Analysis (EE/CA) for the containment of the plume of perchlorate contaminated groundwater extending west from the IRC TS and across Mather Field. Boeing and Aerojet are in the process of constructing facilities to control the plume by extracting groundwater at the plume boundaries, treating the extracted water to remove the pollutants, and discharging the treated water. In addition, Aerojet and Boeing are evaluating alternatives for remediation of the contaminant plumes, both on and off of the IRC TS.

One of the alternatives being evaluated by Boeing and Aerojet for cleaning up the contaminated groundwater is in-situ bioremediation. This process uses a carbon substrate to provide food for the indigenous bacteria to grow. The bacteria will, through reduction processes, remove perchlorate and, hopefully, the VOCs. Aerojet has tested several variations of the in-situ biodegradation process on its own property and conducted a pilot test along the western edge of the IRC TS under Waste Discharge Requirements Order NO. R5-2003-0026. The process has shown significant success in reducing the perchlorate concentrations in the aquifer to below the detection limit of 4  $\mu\text{g/L}$  (the current Action Level established by the California Department of Health Services). Reduction of the VOCs was not as successful without the addition of bacteria (KB-1) known to be able to reduce TCE to ethene and ethane. Boeing proposes to test the bioremediation concept at the Sigma Complex on the IRC TS as described below. If successful, the project would be expanded in an effort to reduce the flux of perchlorate in groundwater from the source areas at the Sigma Complex and allow quicker cleanup of the pollution.

### **Bio-Barrier Pilot Project**

The objectives of the pilot project are to confirm the ability of the indigenous bacteria beneath the Sigma Complex on the IRC TS to biodegrade perchlorate to treatment goals through electron donor

THE BOEING COMPANY

THE SIGMA COMPLEX INSITU GROUNDWATER BIORMEDIATION PROJECT

INACTIVE RANCHO CORDOVA TEST SITE, SACRAMENTO COUNTY

addition, and quantify the rate and extent of perchlorate biodegradation by these indigenous bacteria; assess the impacts of the in-situ bioremediation process on secondary groundwater quality; assess the ability of the active containment system to provide the required level of hydraulic control for plume containment and treatment; identify design and operational factors that influence the successful performance of the in-situ bioremediation approach, and optimize system operation with respect to these factors; and, generate performance, design and cost data that can be used for a full-scale system.

The pilot project will be targeting groundwater in the uppermost water-bearing zone. This unconfined water bearing zone consists of sands and gravels extending from approximately 122-182 feet below ground surface. The groundwater is flowing west-southwest underneath the project area. The estimated groundwater velocity is 300 feet per year. One extraction well, one recharge well, and at least seven groundwater monitor well nests have, or will be, constructed for the project. The extraction well is located on the western edge with the recharge well upgradient of the perchlorate plume along the eastern edge. Groundwater monitor wells are positioned between the injection and extraction wells and downgradient from the injection well. Groundwater will be extracted from the extraction well at up to a total of 150 gallons per minute (gpm) and amended with an electron donor/carbon source and discharged back into the aquifer via the recharge well. The electron donor will be either will likely be citric acid, though acetate, lactate or ethanol could be used.

The electron donor will stimulate the growth of bacteria in a small portion of saturated subsurface to degrade the perchlorate into chloride and oxygen atoms. It is also hoped that the TCE will be degraded by the bacteria to ethene and thence to carbon dioxide. Nitrate concentrations will also be reduced by the bacteria. The electron donor dosage will be balanced with the amount of electron receptor (oxygen, nitrate, perchlorate, and sulfate) present in the extracted groundwater. This will minimize potential adverse impacts on groundwater quality.

Based on past evaluations on the IRCTS and the Aerojet facility, the estimated half-life for reduction of perchlorate is approximately 1 day. Thus, to reduce perchlorate concentrations from 4100 µg/L to less than 4 µg/L will take 10 days within the reactive zone. With an average groundwater velocity of approximately 300 feet/day, the perchlorate would be expected to be removed within seven feet of the recharge well. However, the groundwater velocity at the recharge well will be greater than that of the aquifer in general. At the Aerojet facility, the reduction took place within 25 to 75 feet of the recharge well.

The area downgradient from the test area is degraded by perchlorate for a distance of over two miles. Boeing and Aerojet are in the process of constructing a cleanup action to halt the downgradient migration of the perchlorate plume. This cleanup is being undertaken pursuant to Cleanup and Abatement Order No. 97-012. Thus, waters beneath and downgradient from the test area covered under this permit, are included in a cleanup action that will be construction completed in the near future.

### **Basin Plan, Beneficial Uses, and Regulatory Considerations**

Surface water drainage from the project area is to Morrison Creek, tributary to the Sacramento River. The *Water Quality Control Plan for the California Regional Water Quality Control Board Central Valley Region, Fourth Edition* (Basin Plan), designates beneficial uses, establishes water quality objectives, and contains implementation plans and policies for all waters of the Basin. Beneficial uses

often determine the water quality objectives that apply to a water body. For example, waters designated as municipal and domestic supply must meet the maximum contaminant levels (MCLs) for drinking waters. The Basin Plan sets forth the applicable beneficial uses (industrial, agricultural, and domestic supply in this instance) of groundwater, procedure for application of water quality objectives, and the process for and factors to consider in allocating waste assimilation capacity.

### **Antidegradation**

The antidegradation directives of Section 13000 of the California Water Code require that waters of the State that are better in quality than established water quality objectives be maintained “consistent with the maximum benefit to the people of the State.” Waters can be of high quality for some constituents or beneficial uses and not others. Policies and procedures for complying with this directive are set forth in the Basin Plan (including by reference State Water Board Resolution No. 68-16, “Statement of Policy With Respect to Maintaining High Quality Waters in California,” or “Antidegradation” Policy).

Resolution 68-16 is applied on a case-by-case, constituent-by-constituent basis in determining whether a certain degree of degradation can be justified. It is incumbent upon the Discharger to provide technical information for the Board to evaluate that fully characterizes:

- All waste constituents to be discharged;
- The background quality of the uppermost layer of the uppermost aquifer;
- The background quality of other waters that may be affected;
- The underlying hydrogeologic conditions;
- Waste treatment and control measures;
- How treatment and control measures are justified as best practicable treatment and control;
- The extent the discharge will impact the quality of each aquifer; and
- The expected degradation to water quality objectives.

In allowing a discharge, the Board must comply with CWC section 13263 in setting appropriate conditions. The Board is required, relative to the groundwater that may be affected by the discharge, to implement the Basin Plan and consider the beneficial uses to be protected along with the water quality objectives essential for that purpose. The Board need not authorize the full utilization of the waste assimilation capacity of the groundwater (CWC 13263(b)) and must consider other waste discharges and factors that affect that capacity.

As stated above, groundwater will be extracted, amended with a carbon source and recharged back to the aquifer. The biological activity will reduce the concentrations of VOCs and perchlorate and the carbon source will be completely consumed in the process. Groundwater quality will be monitored to assess the impacts due to the project. The groundwater flowing from the project area will be captured by the extraction system being installed by Aerojet and Boeing. Any residual pollutants remaining from the pilot

THE BOEING COMPANY

THE SIGMA COMPLEX INSITU GROUNDWATER BIORMEDIATION PROJECT

INACTIVE RANCHO CORDOVA TEST SITE, SACRAMENTO COUNTY

project will be captured and removed by that extraction system. No degradation should occur as a result of the discharge.

## **Title 27**

Title 27, CCR, section 20380 et seq. ("Title 27"), contains regulations to address certain discharges to land. Title 27 establishes a waste classification system, specifies siting and construction standards for containment of classified waste, requires extensive monitoring of groundwater and the unsaturated zone for any indication of failure of containment, and specifies closure and post-closure maintenance requirements. Generally, no degradation of groundwater quality by any waste constituent is acceptable. The proposed discharge will not degrade groundwater quality.

## **Proposed Order Terms and Conditions**

### **Discharge Prohibitions and Specifications**

The proposed Order establishes a discharge flow limit of 360,000 gallons per day. The proposed Order's discharge specifications for the electron donor are designed to minimize residual salts and to maintain all beneficial uses of the groundwater.

### **Monitoring Requirements**

Section 13267 of the CWC authorizes the Board to require monitoring and technical reports as necessary to investigate the impact of a waste discharge on waters of the state. In recent years there has been increased emphasis on obtaining all necessary information, assuring the information is timely as well as representative and accurate, and thereby improving accountability of any discharger for meeting the conditions of discharge. Section 13268 of the CWC authorizes assessment civil administrative liability where appropriate.

This Order requires effluent and groundwater monitoring requirements, including flow rates. In order to adequately characterize its discharge, Boeing is required to monitor for VOCs, perchlorate, electron donor, dissolved metals, dissolved oxygen, total dissolved solids and pH.

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